
# Technical and Scientific Considerations for Upland and Riparian Buffer Strips in the Section 404 Permit Process

**PURPOSE:** Effective natural resource management within watersheds often requires the establishment, protection, and management of vegetated buffer strips to provide for physical (e.g., protection of water quality) and ecological (e.g., plant and animal habitat) functions. Since passage and subsequent amendments to the Clean Water Act (CWA), the U. S. Army Corps of Engineers (Corps) has had legal authority during Section 404 permit decisions to require vegetated buffer strips as part of the mitigation for filling wetlands.[1] Among the goals of the CWA are restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters, and attainment of "water quality which provides for the protection and propagation of fish, shellfish, and wildlife" (33 U.S.C. 1251(a)(2)). Vegetated buffer strips, such as forested riparian areas, may be well-suited for this purpose, and "are a critical element of the overall aquatic ecosystem in virtually all watersheds" (Federal Reg. 67(10), p. 2064). Buffer strips are also widely recognized for a variety of functions, including streambank stabilization; erosion control; providing organic matter critical for aquatic organisms; serving as nutrient sinks for the surrounding watershed; water temperature control through shading; reducing flood peaks; and serving as key recharge points for renewing groundwater supplies (DeBano and Schmidt 1990; O'Laughlin and Belt 1995). If designed and managed properly, buffer strips also provide habitat for a large variety of plant and animal species.

**BACKGROUND:** Because of greater awareness of the importance of riparian areas, there has been an increase in requests for buffer strip and corridor design information by Corps Districts and Projects. Many of these requests relate to regulatory issues (e.g., protection of aquatic habitats and associated organisms, mitigation for loss or degradation of jurisdictional wetlands) such as Section 404 permitting under the Clean Water Act. Recent requests for information and technical assistance by Corps Districts on Section 404 permits involving buffer strips, and requests for additional information on buffer and corridor design criteria from Corps natural resources personnel attending Corps "PROSPECT" courses, indicate a strong need for better guidelines based on state-of-the-science criteria.

The Corps has recently made significant changes to the Nationwide Permit (NWP) system. On March 9, 2000, the Corps published in the Federal Register a final notice of changes to the NWP program. The Corps issued five new NWPs and modified six existing NWPs to replace NWP 26, which authorized discharges into nontidal headwaters and isolated waters. These modifications were designed to enhance protection of resources within 100-year floodplains. As part of the guidance under the new NWPs, both upland and riparian vegetated buffer strips can be mandated, in certain situations, by District Engineers as part of a Section 404 permit under the NWP system.

---

1 Although the Corps does not have authority to directly regulate upland areas, there is authority that allows the Corps to consider vegetated buffer strips around wetlands and other waters of the United States (Federal Register, Vol. 65, No. 47, March 9, 2000). Buffer strips outside wetlands and waters of the United States are not an attempt to regulate uplands or to mitigate for impacts to uplands, but are a method available to the Corps to protect and minimize impacts to water quality and to aquatic habitats.

Figure 1. Riparian buffer strips provide numerous physical and ecological functions. Corps of Engineers Regulatory personnel should consider these functions when reviewing permitting decisions potentially affecting rivers, streams, and other aquatic systems (photograph of the Crystal River, Michigan)

The objective of this technical note is to identify technical and scientific considerations regarding upland and riparian buffer strips. Criteria for buffer strip designs are presented that can be considered when assessing the impacts of a proposed development on aquatic systems. Information for this report was primarily developed under the Corps' Ecosystem Management and Restoration Research Program (EMRRP).

**WHAT ARE RIPARIAN AREAS?** Riparian areas are transitional areas between aquatic and upland terrestrial habitats. They occur as long strips of vegetation adjacent to streams, rivers, lakes, reservoirs, and other aquatic systems that affect or are affected by the presence of water. They exist in a variety of landscape settings, including agricultural, forested, suburban, and urban areas. Although the Corps has specific guidelines to delineate jurisdictional wetlands, there are no such standardized criteria for delineating the boundaries of riparian areas. In fact, there is considerable widespread confusion in the literature and among scientists regarding where riparian areas end and "upland" areas begin (Fischer, Martin, and Fischenich 2000). Although jurisdictional wetlands can and do regularly occur within riparian areas, the entire riparian area typically is not comprised of wetlands.

The Corps provided the following definition[1] of vegetated buffers (also commonly known as buffer strips):

> A vegetated upland or wetland area next to rivers, streams, lakes, or other open waters which separates the open water from developed areas, including agricultural land. Vegetated buffers provide a variety of aquatic habitat functions and values (e.g., aquatic habitat for fish and other aquatic organisms, moderation of water temperature changes, and detritus for aquatic food webs) and help improve or maintain local water quality. A vegetated buffer can be established by maintaining an existing vegetated area or planting native trees, shrubs, and herbaceous plants on land next to open waters. Mowed lawns are not considered vegetated buffers because they provide little or no aquatic habitat functions and values. The establishment and maintenance of vegetated buffers is a method of compensatory mitigation that can be used in conjunction with the restoration, creation, enhancement, or preservation of aquatic habitats to ensure that activities authorized by NWPs result in minimal adverse effects to the aquatic environment.

Unfortunately, many riparian areas in North America are degraded to the point that they do not provide their natural or intended functions (e.g., protect water quality or provide wildlife habitat) (Welsch 1991). For example, various activities in uplands result in the movement of non-point source pollution (NPSP) (pesticides, herbicides, fertilizers, sediments) from upland to lowland areas. These pollutants typically are deposited directly into aquatic systems unless an adequate buffer strip intercepts them. This degradation also negatively affects many of the other important functions provided by riparian areas. The management and restoration of riparian corridors and buffer strips are becoming increasingly important options for improving water quality and conserving wildlife populations.

## BUFFER STRIP CONSIDERATIONS DURING THE CORPS' REGULATORY REVIEW AND PERMITTING PROCESS

**Are There Important Resources That Should be Protected or Conserved?** A variety of factors can be considered by Corps regulatory offices during the decision to grant a 404 permit, including conservation, economics, aesthetics, wetlands, cultural values, navigation, fish and wildlife values, water supply, water quality, and other factors important to the public. The Corps "believes that establishing or maintaining existing vegetated buffers to open waters is critical to overall protection of the nation's aquatic ecosystems" (Federal Register 67(10), p. 2065). When decisions are made regarding the significance of a wetland or water body and its subsequent protection, the type and amount of NPSP associated with the proposed development are important considerations. For example, wetlands are often used as "biological filters" that can receive and very efficiently process some NPSP such as fertilizers. Buffer strips adjacent to wetlands designed to remove fertilizer may not need to be as wide as those around wetlands receiving other types of NPSP (e.g., high rates of sedimentation can fill wetlands and affect their ability to function properly). Conversely, NPSP flowing overland or below ground toward rivers, streams, and lakes without adequate buffer strips

1 Definition is from the Regulatory Program of the U.S. Army Corps of Engineers, found in CFR 33 Part 330, Nationwide Permit Program, Final Notice of Issuance, Reissuance, and Modification of Nationwide Permits, March 9, 2000.

may be transported directly into the aquatic system, subsequently degrading water quality. Streams, rivers, and open water bodies do not have the ability to act as efficient filters for NPSP; thus, adequate buffer strips should be a consideration in these situations.

Riparian areas typically comprise a small percentage of the landscape, often less than 1 percent, yet they frequently harbor a disproportionately high number of wildlife species and perform a disparate number of ecological functions compared to most upland habitats. These strips of vegetation can provide habitat for a wide variety of plants and animals, provide a visual and noise buffer that reduces the disturbance of human developments on breeding and nesting birds, and provide corridors for movement from one habitat area to another (e.g., dispersing mammals, neotropical migrant birds using "stopover" habitat on their way to and from breeding grounds). Vegetation adjacent to streams and rivers also provides shading that moderates stream temperatures, and provides input of woody debris and other organic material important to aquatic organisms. Downed woody vegetation in the riparian area also provides microhabitats for reptiles, amphibians, and small mammals, and provides substrates for insects. Snags (dead, standing timber) within riparian areas provide cavities for a variety of birds and mammals. Encroachment into the riparian area during developments can negatively affect any or all of these important functions.

Riparian areas provide habitat for a large number of threatened and endangered species. Species such as the bald eagle (*Haliaeetus leucocephalus*) (Guilfoyle et al. 2000), the southwestern willow flycatcher (*Epidonax traillii extimus*), and least Bell's vireo (*Vireo bellii pusillus*) (Guilfoyle and Wolters 2001) have been major issues on some Corps project lands.

**How wide should the buffer strip be?** Unfortunately, there is no "one-size-fits-all" design for an ideal riparian buffer strip (Fischer and Fischenich 2000). Many factors including slope, soil type, adjacent land uses, floodplain, vegetation type, and watershed condition play a role in planning proper buffer strips.

If fish and wildlife populations are considered in the decision process, several recent scientific studies have recommended widths of buffer strips for different faunal groups. Riparian buffer strip width recommendations in these studies typically far exceed buffer strip width based solely on water quality (Fischer 1999; Fischer and Fischenich 2000). For example, the minimum recommended width of riparian buffer strips from most studies of avian populations is 100 m (300 ft). Other studies addressing ecological concerns associated with riparian buffer strips also tend to provide recommendations for buffer strips far in excess of what is typically recommended for water quality. While 100-m-wide buffer strips are not always possible, given the constraints of floodplain width, land ownership, and Corps statutory authority, the wider the buffer strip adjacent to a water body, the greater the potential for providing for more ecological functions.

When determining the appropriate design of vegetated buffers, one may consider the magnitude of the adverse effects on the aquatic system caused by the proposed development and require compensatory mitigation that will ensure that adverse effects are minimal. In most cases, buffer strips should at least extend the length of the riverbank or shoreline associated with the project or development. Continuous buffer strips may be more effective at moderating stream temperatures, reducing gaps in protection from NPSP, and providing better habitat and movement corridors for wildlife by reducing fragmentation.

**What Are the Different Types of Buffer Strips That Can be Used to Protect Resources?** The most commonly used type of buffer strip for water quality and wildlife is the riparian forest buffer. These buffer strips are usually comprised of a mixture of trees and shrubs. Filter strips, which are usually comprised of grasses and other herbaceous plants, are also commonly used, especially adjacent to agricultural fields. These two types of buffer strips sometimes are used in combination under a design called a three-zone buffer (Welsch 1991). Zone 1 begins at the edge of the active channel and is dominated by existing or planted native woody vegetation. This zone, which should remain free of disturbance, provides bank stabilization, coarse woody debris, stream shading, and habitat. Zone 2 is also forested and comprised of plant species similar to Zone 1. If water quality maintenance is a primary goal of the buffer strip, periodic vegetation removal in this zone (e.g., selection-cut timber harvest) can occur on a limited basis to maintain plant vigor that improves uptake of excess nutrients from NPSP. Zone 3 is the most proximal to uplands and should be comprised of native herbaceous vegetation (e.g., grasses and forbs) that facilitate sediment filtering, nutrient uptake, and the process of spreading flow of water from uplands evenly through the buffer strip.

**What Should Comprise the Buffer Strip?** When feasible, buffer strips should be planted with a mixture of native herbaceous and woody plants. Vegetation should be dense enough at ground level so that water entering the buffer from the upland spreads over the buffer strip instead of running through in channels and bypassing the filtering capacity of the vegetation (Dillaha et al. 1989). Woody plants, especially trees, are important components of an effective vegetated buffer. Seedlings and saplings of trees planted in the buffer strip tend to mature relatively quickly in the rich riparian soils, providing shade to the open waters, as well as substantial amounts of detritus that is an important component of aquatic food webs. Woody vegetation in riparian areas often slows the velocity of floodwaters, which can provide water quality benefits by allowing sediment to drop out of suspension and decrease the sediment load in the water column. Herbaceous vegetation can also be planted and allowed to succeed naturally into a woody plant community. While nonnative plant species may work just as well at controlling NPSP as native species, native plants are important for the habitat functions of vegetated buffers. Many nonnative plants are highly invasive, and can form dense monocultures that are not as high in value as native plants are for wildlife. There is also a great deal of interest in planting a mixture of native warm-season grasses (e.g., big bluestem, little bluestem, Indiangrass, switchgrass) instead of other popular cool-season grasses (e.g., reed canarygrass, Kentucky 31 tall fescue, orchardgrass, bluegrass) that have historically been recommended, but provide little or no value to wildlife.

**Does the Position of the Proposed Development Within the Watershed Affect Design?** Stream order and spatial placement of buffer strips within a watershed are important factors in determining the importance of a buffer strip, and can have a significant effect on water quality in a system. Although buffer strips are important along all river and stream reaches, those in headwater streams (i.e., those adjacent to first, second, and third order systems) often have much greater influences on overall water quality within a watershed than those buffers occurring in downstream reaches (Pallone and Todd 1997). Headwater streams, which usually occur at the highest elevations in the watershed, tend to comprise the majority of stream miles in a watershed, and thus, often receive the most NPSP. Buffer strips farther down the stream and river continuum have proportionally less impact on polluted water either already in, or entering, the system. Even the best buffer strips along larger rivers and streams cannot significantly improve water that has been degraded by im-

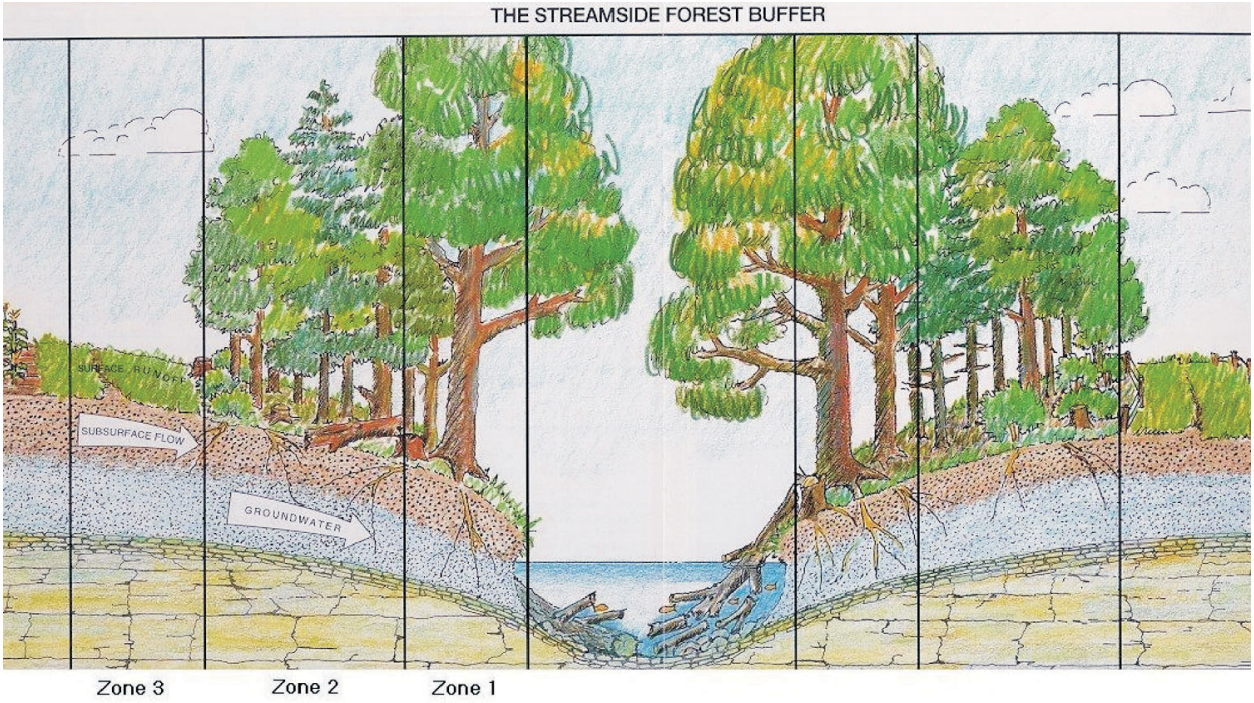


Figure 2. The three-zone buffer strip design (modified from Welsch (1991))

proper buffer practices higher in the watershed. However, buffer strips along larger systems should never be overlooked since they tend to be longer and wider than those along smaller systems, thus potentially providing better wildlife habitat and movement corridors (Lock and Naiman 1998).

**CONCLUSIONS:** Vegetated buffer strips provide numerous physical and ecological functions. There has been an increase in interest by the Corps in implementing improved buffer strip designs on project lands as well as in Regulatory review of Section 404 permit decisions. The Clean Water Act provides the Corps with legal authority during permit decisions to require vegetated buffer strips as part of the mitigation for impacts to wetlands and waters of the United States. Guidance on buffer strips was provided in the new and updated Nationwide Permits recently published by the Corps in the Federal Register. Some Corps Districts are using this and other scientific information to make improved decisions on Section 404 permits involving significant riparian habitats (see Table 1 for a checklist of considerations regarding buffer strips). Although most buffer strips are implemented for the maintenance or improvement of water quality, improved information is now available to enhance buffer strip designs for additional ecological benefits.

**Table 1**
**Step-wise Buffer Strip Considerations**

| | |
|---|---|
| 1. Determine if there are significant resources present that need to be protected or conserved by a buffer strip. | |
| 2. Select the type of buffer strip for the situation. | Water quality concerns can be addressed in some instances with vegetated filter strips in uplands and riparian/wetland areas. Riparian forest buffer strips are more commonly used to provide for both water quality protection and conservation of natural resources. Review of proximal reference sites may assist in selecting type of buffer. |
| 3. Select either a fixed-width buffer or a variable-width buffer. | Decision will be based on resources requiring protection. A variable-width buffer strip may be necessary at sites where some areas are more important than others. |
| 4. Determine proper vegetation composition of the buffer strip. | Buffer strips may be comprised of a variety of native tree, shrub, and herbaceous species (Federal Register 67(10), p. 2093). Fischer and Fischenich (2000) provide a starting point for recommended vegetation. |

**ACKNOWLEDGEMENTS:** This study was supported by the Wetlands Regulatory Assistance Program, U.S. Army Engineer Research and Development Center, Environmental Laboratory (EL). Technical reviews were provided by Dr. Michael F. Passmore and Mr. Chester O. Martin, EL; and Mr. Jim Townsend, Chief, Regulatory Branch, Louisville District, U.S. Army Corps of Engineers.

**POINTS OF CONTACT:** For additional information, contact Dr. Richard A. Fischer, U. S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, (601-634-3983, *Richard.A. Fischer@erdc.usace.army.mil*) or the Program Manager of the Wetlands Regulatory Assistance Program, Mr. Bob Lazor (601-634-2935, *Bob.L.Lazor@erdc.usace.army.mil*). This technical note was written by Dr. Richard A. Fischer (Environmental Laboratory, ERDC). This document should be cited as follows:

> Fischer, R. A. (2001). "Suggestions to assist Section 404 permit decisions involving upland and riparian buffer strips," WRAP Technical Notes Collection (ERDC TN-WRAP-01-06), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/wrap/*

## REFERENCES

Castelle, A. J., Johnson, A. W., and Conolly, C. (1994). "Wetland and stream buffer size requirements—A review." *Journal of Environmental Quality* 23, 878-882.

Debano, L. F., and Schmidt, L. J. (1990). "Potential for enhancing riparian habitat in the southwestern United States with watershed practices," *Forest Ecology and Management* 33/34, 385-403.

Dillaha, T. A., Reneau, R. B., Mostaghimi, S., and Lee, D. (1989). "Vegetative filter strips for Agricultural nonpoint source pollution control," *Transactions of the American Society of Agricultural Engineers.* 32, 513-519.

Fischer, R. A. (1999). "Widths of riparian zones for birds." EMRRP Technical Notes Collection (TN EMRRP-SI-9), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Fischer, R. A., Martin, C. O., and Fischenich, J. C. (2000). "Improving riparian buffer strips and corridors for water quality and wildlife." *Proceedings of the International Conference on Riparian Ecology and Management in Multi-use Watersheds.* P. J. Wigington and R. L. Beschta, ed., TPS-00-2, American Water Resources Association, Middleburg, VA, 457-462.

Fischer, R. A., and Fischenich, J. C. (2000). "Design recommendations for riparian corridors and vegetated buffer strips." EMRRP Technical Notes Collection (TN EMRRP-SR-24), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Guilfoyle, M. P., and Wolters, M. S. (2001). "Sensitive western riparian songbirds potentially impacted by USACE reservoir operations," EMRRP Technical Notes Collection (TN EMRRP-SI-19), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Guilfoyle, M. P., Evans, D. E., Fischer, R. A., and Martin, C. O. (2000). "Riparian raptors on USACE projects: Bald eagle (Haliaeetus leucocephalus)." EMRRP Technical Notes Collection (ERDC TN-EMRRP-SI-12), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Lock, P. A., and Naiman, R. J. (1998). "Effects of stream size on bird community structure in coastal temperate forests of the Pacific Northwest, U.S.A." *Journal of Biogeography* 25, 773-782.

O'Laughlin, J., and Belt, G. H. (1995). "Functional approaches to riparian buffer strip design," *Journal of Forestry* 93, 29-32.

Pallone, R. S., and Todd, A. H. (1997). "Chesapeake Bay riparian handbook: A guide for establishing and maintaining riparian forest buffers," USDA Forest Service, NA-TP-02-97, Radnor, PA.

Welsch, D. J. (1991). "Riparian forest buffers: Function and design for protection and enhancement of water resources," USDA Forest Service Report NA-AP-07-91.

# Appendix A: Case Studies

**HUMBUG MARSH, MICHIGAN:** In August 1999, the U.S. Army Engineer District, Detroit, requested that ERDC provide technical assistance in a controversial Section 404 permit review. The objectives were to assess the importance and effectiveness of existing buffer strips in providing wildlife habitat and protecting water quality at a proposed development site along approximately 1 mile of the Detroit River. The applicant's stated purpose for the development was to create a residential waterfront development with a nine-hole golf course. The proposed development consists of an 8-hectare (ha) island (Humbug Island), a 93-ha mainland area, and 72 ha of water and associated wetlands.

Several years ago, a 45-ha area along the mainland of Humbug Marsh was obtained by a private company as mitigation for an unrelated action. This company was directed to establish a conservation easement on the property to include an 18-m upland buffer to protect associated wetlands; this action was insisted upon by the Environmental Protection Agency, U.S. Fish and Wildlife Service, and Michigan Department of Natural Resources. The property was later purchased by another company that applied for a 404 permit to fill wetlands as part of a residential and golf course development for the site. This company subsequently bush hogged much of the property, including an approximately 640-m-long buffer strip that was protected by conservation easement. Prior to vegetation removal, much of the easement was comprised of riparian vegetation that provided a transitional zone between aquatic and upland habitats.

The lower Detroit River, including Humbug Marsh, is considered the most important fish spawning and nursery habitat in the entire Detroit River and much of Lake Erie. Humbug Marsh is recognized as a significant spawning and nursery area for forage fishes and contributes to a regionally important walleye (*Stizostedion vitreum*) fishery. The marsh and associated vegetation also serve as habitat for a variety of waterfowl, wading birds, raptors, passerines, and shorebirds. The vegetation on Humbug Island is diverse, the canopy is unfragmented, and there are numerous snags and downed trees that contribute to the value of the island for wildlife. Natural vegetation along the mainland serves as a buffer strip that protects wetlands and the river from upland disturbances, and provides wildlife habitat or a diversity of fauna.

**Assessment by ERDC.** After conducting a site evaluation and investigating the literature and other sources of information, ERDC concluded that the 18-m buffer strip likely was inadequate in providing proper buffering function from upland development, especially after the bush hogging operation, and would not be able to provide functions required to support healthy wildlife populations in the riparian area and associated wetlands. ERDC made the following recommendations in regard to riparian buffers and the Humburg Marsh complex:

- Buffer strips comprised of native uncut vegetation at least 30 m wide should be provided to adequately protect wetland and aquatic habitats from potential NPSP from upland developments.
- Buffer strips at least 100 m wide should be established to provide adequate wildlife habitat and movement corridors.
- Impacts of the clearing operation conducted in the conservation easement should be offset by rehabilitating the existing easement area with plantings of preferred wildlife trees (e.g., oak

[*Quercus* spp.], hickory [*Carya* spp.]) and native shrubs, and by extending the width of the buffer strip to reclaim habitat lost by the clearing operation.

- No development should be allowed on Humbug Island. Disturbances to the island could be especially detrimental to fisheries because of the relatively narrow wetland fringe that buffers aquatic areas from the adjacent upland, and to migrant birds that use the Detroit River as a migration corridor during spring and fall.

## Findings in the Corps' Environmental Assessment.

***Impacts to riparian areas, wetlands, and aquatic systems.*** The overall site is a relatively rare and unique habitat and is one of the few remaining vestiges of a habitat that was once regionally abundant. Wildlife impacts on the site are potentially the most significant adverse impact associated with the project. The project, specifically clearing of the riparian area, would eliminate or significantly alter reproductive, foraging, and resting habitat, and interrupt a travel corridor for upland game birds, waterfowl, wading birds, shorebirds, songbirds, small and large mammals, reptiles, amphibians, and invertebrates that are important in the food chain. A proposed causeway allowing access to and development of the island, would create some upland habitat. However, the exchange of upland habitat for increasingly rare riparian habitat in the area would lead to an overall decrease in terrestrial biota diversity and productivity.

***Impacts to uplands.*** The vast majority of uplands on the mainland and island occur outside of direct Corps jurisdiction. However, activities associated with the development would require discharges of dredged and fill materials for upland access and thus come within Corps control and responsibility. The Corps of Engineers can require vegetated upland buffers adjacent to open waters of the United States as part of a Clean Water Act Section 404 permit, since these buffers provide many of same functions as wetland buffer strips.

Proposed construction of the residential development and golf course would remove existing habitat in the wetland impact areas and over most of the uplands on the site. This would cause a substantial long-term adverse impact on nesting, feeding, and resting habitat for waterfowl, wading birds, shorebirds, and songbirds, as well as for small and large mammals. Human activity, including noise and vehicle movement associated with these developments, would displace wildlife that currently inhabit the site and those that use uplands for roosting, resting, rearing, and the foraging habitat. Development of the uplands on the island and the mainland would destroy a large area that is currently used by many species of migratory songbirds and other types of birds. Current research on migratory songbirds has focused on habitat loss all along their migration routes as one of several factors contributing to declining populations.

Clearing of vegetation in uplands, even with an 18-m buffer strip, would lead to an increase in construction and subsequent occupation of housing. This would potentially lead to an increase in stress and/or exclusion of wildlife species sensitive to disturbance, including some migrating waterfowl, eagles and osprey, and other birds. Only those species or individuals that tolerate these activities will use the area. These conclusions would extend to mammals, as well.

The Detroit District recommended the following proposed alternatives that would meet Section 404(b)1 guidelines:

- Full application of ERDC's 100-m recommendation to all areas including the island, the mainland shoreline along the open water, adjacent wetlands, and to all wetland pockets and fingers within the upland portion of the site. This will minimize adverse impacts to aquatic resources and preserve wildlife habitat.
- Requirement of a 45-m buffer along a section of the shoreline. This will protect slightly less valuable shoreline areas.

**Final Decision.** The proposed development was not in the overall public interest, and did not comply with Section 404(b)(1) guidelines as interpreted by the District Commander, Detroit. The District found there would be major long- and short-term negative impacts on aquatic plants and animals as a result of the proposed work. Negative impacts would be greatly reduced if the permit were denied, modified to exclude the island causeway (and therefore the island development), and/or issued with special conditions to require a substantial buffer strip in common ownership, and to control turbidity during and after construction. Special conditions that would establish easements/buffer strips of sufficient width to preserve wildlife use levels within the waterway, wetlands, and an appropriately sized upland buffer could decrease secondary impacts of development. It would be crucial to maintain easements/buffers in one ownership to increase enforceability.

**CRYSTAL RIVER, MICHIGAN:** The ERDC also assisted the U.S. Army Engineer District, Detroit in assessing the values and potential impacts of a proposed 18-hole golf course development within and adjacent to the riparian area associated with the Crystal River in northern Michigan. The developer proposed two different plans for constructing an 18-hole golf course on the property. The first plan was to construct the course with 4 holes located within the riparian area of the Crystal River, and the remaining 14 holes interspersed among upland and wetlands. An alternative plan proposed that all 18 holes be kept out of the riparian area; however, this plan included a housing development within the Crystal River riparian area. The primary issues and concerns associated with the proposed development were the potential impacts to the ecology of riparian habitat adjacent to the Crystal River, and potential impacts to water quality within the river and adjacent wetlands. Objectives of the ERDC were to evaluate potential impacts to riparian zone habitat associated with the Crystal River, and evaluate the approach taken by the applicant's consultant using the Pesticide Root Zone Model (PRZM), which addressed potential transport of NPSP to the river.

The Crystal River is a highly sinuous system that flows from the southern end of Glen Lake approximately 15 river miles before entering Lake Michigan. The river meanders through topography comprised primarily of a series of dunes and swales, characterized as the "Wooded Dune and Swale Complex" by the Michigan Natural Features Inventory. This natural community type apparently is unique to the Lower Peninsula of Michigan. The river is heavily used for recreational canoeing during summer months.

**Assessment by ERDC.** After conducting a site evaluation and investigating the literature and other sources of information, ERDC concluded that the proposed development within the riparian area of the Crystal River (including both proposed alternatives) would have negative consequences to the ecology of the system, and negatively impact water quality in the river.

**Impacts to Riparian Habitat.** Construction and development of the four holes in the riparian area would involve significant clearing of riparian vegetation. Two of the holes would occur entirely on

one side or the other of the river and run parallel to the river channel; a third hole would have golfers teeing off directly across the river from the tee box; the fourth hole parallels the river but golfers would tee off directly upstream to another fairway paralleling the river.

The loss of riparian habitat on the proposed site may appear insignificant because of the relatively small amount of acreage proposed for conversion. However, the loss of habitat along the river would create a fragmented riparian corridor leading to a break in continuity that many organisms require for movements among habitats. Based on habitat characteristics observed during a site visit, the site likely supports a diversity of animal life, including numerous species of breeding and wintering birds, reptiles, amphibians, large and small mammals, and invertebrates. The site also likely provides suitable habitat for a diversity of both neotropical and nearctic migrant birds as they move to and from seasonal ranges. Due to the relatively undisturbed habitat present on the site, the juxtaposition of both upland ridges and wetland swales, and the proximity of open water in the Crystal River, any clearing or development within the proposed site will substantially reduce or eliminate suitable habitat for many species of plants and animals.

**Effects on Water Quality.** Pesticides applied to golf courses to control weeds, insects, burrowing mammals, and other pest species have proven to be harmful to wildlife. Several examples of direct and indirect effects of pesticides on wildlife were cited in an ERDC report to the District. The PRZM was used by the applicant to assess the extent to which pesticides could leach through the soil profile, reach groundwater, and move offsite (i.e., into the Crystal River). Either plan appears to have nearly the same golf course surface area for application of fertilizers, herbicides, and pesticides. The alternative plan replaces the impact of a golf course with a housing project.

There are potential water quality impacts associated with housing developments in the riparian zone. First, construction will disrupt soil that likely will run off into adjacent wetlands and the river channel. Second, any lawns associated with homes will likely be treated with fertilizers, herbicides, and pesticides. The use of these chemicals typically is not regulated under conditions used at most golf courses. Third, if septic systems are constructed for these homes, there is potential for movement of wastewater into wetlands (and groundwater) and the river channel. Finally, construction of housing, roads, and driveways will increase the amount of impervious surface area potentially impacting surface water quality and quantity entering wetlands and the Crystal River.

### Findings in the Corps' Environmental Assessment.

***Impact on riparian habitat.*** The project would have major, long-term, negative impacts on the terrestrial and aquatic biota. Construction along the shoreline would eliminate/alter habitat for amphibious animals and other organisms that require the natural land-water transitional habitat. A variety of organisms would be displaced from their habitat by impacts of the proposed construction and resulting use. Housing development would have a greater impact than a golf course development. The newly created landscaped upland would furnish habitat for those few species adapted to uplands.

Implementation of the proposed activity would impact upon the ecology and integrity of valuable resources: wetlands, migratory bird stopover and foraging point, globally rare habitat limited to the Great Lakes region and of national and international significance. Although the entire site is clearly

of high quality and significance, the value of the riparian habitat is considerably higher than habitats outside the riparian zone.

***Impacts on water quality.*** The Detroit District found that the work would negatively impact an area that filters rainfall, runoff, groundwater, and floodwaters that would otherwise directly enter the waterway, and would replace it with a new source area for runoff pollutants (e.g., lawn fertilizers, herbicides, pesticides, road salt, oil, grease, and septic runoff/leachate). This would cause a long-term negative impact on water quality. Reductions of riparian vegetation along the waterway would cause major adverse impacts to water chemistry, temperature, and turbidity. Failure of septic systems would result in very serious and very likely significant, adverse impacts to water quality.

Clearing and fertilization within the riparian area, particularly within 30 m of the river, would have the greatest potential impact. Inclusion of substantial riparian buffers and avoidance of the riparian area of the Crystal River would substantially reduce, but not eliminate, the potential for significant impact.

**Final Decision.** Both of the proposed alternative designs for the golf course and housing development were not in the overall public interest, and did not comply with Section 404(b)(1) guidelines as designed. The DE stated that although the applicant's preferred alternative, which was development of a course located within and adjacent to the Crystal River riparian zone, would have benefits to economics and rights of property ownership, it would have significant adverse impacts on conservation and overall ecology, terrestrial biota, wetlands, visual aesthetics, recreation, safety, and designated scenic and recreational values. Additionally, the cumulative impact of the loss of riparian habitat would be significant. The DE also suggested the proposed development would have significant impact to water quality and the aquatic biota, have potential adverse impacts on water supply and conservation, and be contrary to the Section 404(b)(1) guidelines.

The District Engineer did recommend an alternative that would not be contrary to the overall public interest and would meet Section 404(b) (1) guidelines:

- Confining the entire course to an area outside of the riparian zone of the Crystal River.
- Mitigating to include the permanent conservation of approximately 47 acres of land within and adjacent to the Crystal River riparian zone (owned or controlled by the applicant).
- Developing a detailed, enforceable water quality monitoring plan.
- Further reducing the wetland impact and avoidance of the riparian corridor in other areas of the proposed project.